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# Increased risk of death with cervical spine immobilisation in penetrating cervical trauma

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ABSTRACT

The purpose of this study was to determine if cervical spine immobilisation was related to patient mortality in penetrating cervical trauma. One hundred and ninety-nine patient charts from the Louisiana State University Health Sciences Center New Orleans (Charity Hospital, New Orleans) were examined. Charts were identified by searching the Charity Hospital Trauma Registry from 01/01/1994 to 04/17/2003 for all cases of penetrating cervical trauma. Thirty-five patient deaths were identified. Cervical spine immobilisation was associated with an increased risk of death ($p < 0.02$, odds ratio 2.77, 95% CI 1.18–6.49).



## Introduction

Vascular and airway injuries complicating penetrating cervical trauma require emergency intervention. Vascular injury complicates over 25% of penetrating cervical trauma with an associated mortality of up to 50%.[5,12,14,17,20] Exsanguination was reported as the cause of 50% of penetrating cervical trauma deaths[20] and is the leading cause of death in patients with penetrating cervical trauma.[14,16] Airway injury occurs in approximately 10–18% of patients with penetrating cervical trauma.[14,16] The rapid mortality associated with vascular and respiratory tract injuries has lead many authors to stress the importance immediately treating these life-threatening injuries before addressing concerns about cervical spine instability.[8,9,10,12,15,19] Increased mortality with delayed transport to definitive surgical care in cases of penetrating cervical trauma has been reported.[7] Transport delays from cervical spine protection measures have been variably reported from a mean of 8 min to >30 min.[1,6] Clevenger et al. demonstrated that patients with penetrating trauma experienced a fourfold increase in on scene times with traditional field preparation as compared to a "scoop and run" policy in which rapid patient transport was emphasised.[6] Approximately 75% of the total transport time was accounted for by time on scene.[6] Mean total field times were reduced 43% from 46 min to 20 min[6] by initiation of the "scoop and run" policy. This decreased field time translated to increased patient survival from resuscitative thoracotomy. Seamon et al. reported increased mortality associated with cervical spine immobilisation (c-spine immobilisation) in penetrating trauma patients requiring resuscitative thoracotomy.[19]

Cervical collars can impede medical care.[13,15,18] Endotracheal intubation was associated with increased attempts and higher failure rates in c-spine immobilised patients.[11,13] Compromised survival resulting from reluctance to remove a cervical collar to treat life-threatening injuries has been reported.[2] Barkana et al. emphasised that physical manifestations indicating the severity of injury can be masked by cervical collars.[3] Indicators of severe penetrating cervical injury include active external bleeding, the presence of a cervical bruit or thrill, dysphonia, dysphagia, subcutaneous emphysema, oropharyngeal haemorrhage, a sucking neck wound, neurological deficits, and a large or expanding or pulsatile haematoma.[3,4] Five of these nine clinical indicators of significant injury with penetrating cervical trauma can be hidden by the presence of a cervical collar; active external bleeding, a cervical bruit or thrill, subcutaneous emphysema, a sucking neck wound, and a large or expanding or pulsatile haematoma. Britt and Trunkey both recommended direct pressure to treat cervical haemorrhage, which can clearly be encumbered by a cervical collar.[4,14] Barkana also noted that tracheal deviation can be obscured by a cervical collar.[3]

No studies have examined the effect of c-spine immobilisation and patient survival in penetrating cervical trauma. C-spine immobilisation was hypothesised to negatively impact outcome in penetrating cervical trauma given (1) the frequency and severity of associated vascular and respiratory tract injuries, (2) the time requirements for field c-spine immobilisation, and (3) the possibility of impeded medical care. The purpose of this study was to determine if patient mortality differed between those patients who were or were not c-spine immobilised.

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## Materials and methods

Retrospective chart analysis performed from the trauma registry of an American College of Surgeons, level I trauma centre. The Louisiana State University Health Sciences Center, New Orleans (Charity Hospital, New Orleans), Trauma Registry was searched from 01/01/1994 to 04/17/2003 for all cases of penetrating cervical trauma. Charts were excluded for lack of penetrating cervical trauma, incompleteness, death, patient elopements prior to evaluation and patient discharges "against medical advice." Patients were grouped according to the presence or absence of neurological injury, cervical spine fracture, and cervical spine immobilisation. Age, sex, race, mechanism of injury, Glasgow Coma Scale (GCS) level on arrival, neurological findings on arrival, zone of injury, associated injuries, imaging studies and results, operations performed, neurological sequelae and disposition from the hospital were also recorded. Institutional review board (IRB) approval was obtained from Tulane University, Louisiana State University, New Orleans, and Louisiana State University Health Sciences Center, New Orleans.

Patient data were entered into a database and described statistically and presented in frequency and proportion using the database's inherent computational software (Microsoft Excel 2000, Redmond, WA). Tests for comparing the proportion difference between two conditions were conducted by chi-square ($\chi^2$) statistic using SAS v9.1 (SAS Institute Inc., Cary, NC). Significance was accepted for $p < 0.05$.

Charity Hospital received approximately 2000 penetrating injuries per year during the study period. Trauma coverage at this institution was the responsibility of Tulane University (Tulane) and Louisiana State University, New Orleans (LSU). Trauma surgery call alternated between these two institutions daily. Neurosurgical, orthopaedic, and urological surgery also rotated daily with their respective institution trauma surgery services. Radiology services were provided by senior radiology residents and staff radiologists of the LSU Department of Radiology. Emergency medicine coverage was continuously provided by LSU emergency medicine staff and residents.

Treatment of cervical spine injuries differed based on the presence or absence of associated neurological injury. LSU or Tulane neurosurgery was responsible for cervical spine injuries with associated neurological symptoms. LSU or Tulane orthopaedic surgery assumed care of cervical spine injuries without neurological symptoms. Cervical instability was based on the three-column system. Radiology provided initial reports of instability. Conclusive diagnosis of cervical instability was the responsibility of the attendant neurosurgical or orthopaedic surgery service.

## Results

Eight hundred and forty-seven charts were identified. The charts were arranged alphabetically by last name and then sequentially numbered. Charts were linearly and sequentially examined. The total number of patient charts reviewed was 199 before Hurricane Katrina destroyed the remaining charts. Charts were examined from *A* through *FAZ* before Hurricane Katrina struck. Patients were evenly distributed by year over the study interim. The number of patients per year ranged from 18 to 30 except for the 3 months in 2003 in which there were only 3 patients. Eleven charts (5.53% of all charts) were excluded. Three charts were excluded due to incomplete medical records. Another three patients' charts were excluded because they left against medical advice prior to full evaluation. Five patients were excluded on the basis of no penetrating cervical trauma. The total number of studied patients was 188.

Thirty-five patients died in this study yielding a relative mortality of 22.88% (35/153). Twenty-seven of these patients were c-spine immobilised and 8 were not c-spine immobilised. Gunshot wounds comprised 94% of the deaths and stab wounds were responsible for 6%. Dead patients were mostly men (32 men/3 women) and were predominantly African American (32 African American/2 Caucasian/1 other).

Twelve patients died with only cervical injuries and 11 were c-spine immobilised. Twenty-three patients incurred additional penetrating injuries including thoracic, abdominal, intracranial-facial and extremity. Fifteen of these multiply injured patients were c-spine immobilised.

One hundred and seven patients had isolated penetrating cervical trauma. Ten of these patients died and were c-spine immobilised. One patient death in this group occurred without c-spine immobilisation. Fifty-one patients survived with c-spine immobilisation and 45 survived without c-spine immobilisation.

Twenty-five patient deaths, 71.43% of all dead patients, occurred in the Emergency Department. The mean age of patients dying in the Emergency Department was 27.58 years with a standard deviation of ±9.86 years. Twenty-two patients arrived with cardiopulmonary resuscitation (CPR) in progress. Eighteen of these 22 patients were c-spine immobilised. One c-spine immobilised patient developed cardiac arrest in the ED. Seven Emergency Department deaths (28%) were pronounced death on arrival (DOA) (Table 1). Six DOA patients were c-spine immobilised. All of the DOA patients were shot. Two of the Emergency Department deaths resulted from stabbings and the remaining 23 were shot.

Any patient death occurring after leaving the ED was considered an "in hospital" death. Ten patients died in the hospital and constituted 28.57% of all dead patients. All in hospital deaths resulted from shootings. The mean age of this group was 32.00 years with a standard deviation of ±14.40 years. Mean age between the hospital and Emergency Department death groups was comparable ($p = 0.405$). Eight patients who died in the hospital were taken directly to the operating room. Eighty percent of hospital death patients were c-spine immobilised, and 20% were not c-spine immobilised. Cardiac arrest in the operating room was the leading cause of hospital mortality (4/10; 40%) (Table 2). Multisystem organ failure and anoxic brain injury were the second leading cause of death in this group.

## Discussion

C-spine immobilisation in this study was associated with an increased risk of death ($p = 0.016$, odds ratio 2.77, 95% CI 1.18–6.49). Most of the patients who died in the Emergency Department presented with paroxysmal electrical activity (PEA) cardiac arrest indicating that exsanguination or hypoxia was the most probable cause of death. Multiply injured patients were separated from those patients with isolated cervical injury to examine the mortality risk of c-spine immobilisation with penetrating cervical trauma only. C-spine immobilisation was again associated with an increased risk of death ($p = 0.038$, odds ratio 8.82, 95% CI 1.09–194.19). Death on arrival was not associated with c-spine immobilisation ($p = 0.29$), and c-spine immobilisation was not associated with an increased risk of death in patients with multiple penetrating injuries ($p = 0.65$).

Eighteen of the 22 patients who died in the Emergency Department arrived c-spine immobilised with CPR in progress. C-spine immobilisation was an independent predictor of CPR on arrival ($p = 0.037$, odds ratio 3.53, 95% CI 1.06–12.95). Patients with cardiac arrest in the operating room following direct admission from the ED were combined with patients receiving CPR on arrival. This combined group of 26 patients represented the total number of patients with cardiac arrest in the pre-hospital and early-